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Original Article

Nutrition Practices of Lithuanian Elite International and National-level Male Bodybuilders in the Pre-competition Period

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Abstract

Objectives: To compare the pre-competition nutrition practices of Lithuanian elite international-level (IL) and national-level (NL) bodybuilders. **Methods**: Sixteen male bodybuilders (n=8 per group) were enrolled. The IL group comprised individuals achieving 1st to 4th place in the World and European Championships organized by the IFBB, whereas the NL group ranked between 1st and 6th place in the national championships. Body mass and diet data were obtained via a questionnaire. A repeated-measures ANOVA was performed using time as a within factor and group as a between factor. **Results**: Both groups experienced a reduction in body mass during the pre-competition phase (p<0.001), which was slower in the IL than in the NL group (p=0.048). Both groups exhibited a reduction in caloric (p<0.001), carbohydrate (p<0.001), and fat (p=0.006) intake relative to body mass, but not in protein intake. Nevertheless, the IL group had a higher intake of calories (p=0.015), protein (p<0.001), but not carbohydrates relative to body mass vs. the NL group. **Conclusions**: The Lithuanian IL and NL bodybuilders both reduced calories by cutting fat and carbohydrates during pre-competition. The IL group maintained higher calorie and protein intake, resulting in similar body mass loss but at a slower rate than the NL group.

Keywords: Calories, Carbohydrate, Dieting, Fat, Protein

Introduction

Bodybuilding has experienced a large increase in popularity over the last few decades, with a growing number of individuals engaging in this activity as either a competitive sport or a recreational pursuit[1]. During bodybuilding competitions, the evaluation criteria encompass the size, shape, and symmetry of muscles. To prepare for competitions, bodybuilders engage in modified training routines and diet, which can be divided into two distinctive periods: the off-season phase and the pre-competition phase. The off-season phase, lasting between 4 and 6 months depending on annual competition frequency, primarily focuses on muscle hypertrophy while also aiming to minimize any muscle asymmetry and weaknesses. Conversely, the aim of the pre-competition phase is to achieve optimal muscle "separation" and overall "body aesthetics," and typically lasts 3–4 months[2-4].

To achieve the desired muscle "separation" and overall "body aesthetics" during the pre-competition training phase, it is key to reduce body fat while preserving muscle mass. Training routines undergo slight modifications during this phase, with the primary emphasis shifting toward dietary interventions. As the competition draws nearer, there is a reduction in calorie intake, an increase in protein consumption, and the integration of aerobic exercise with strength training[5,6]. The comprehensive systematic review by Spendlove et al.[7] revealed that protein intake ranges from as little as 1.9 to as much as 4.3 g/kg of body mass per day, whereas carbohydrates are consumed up to 3.8 g/

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kg per day in the pre-competition period. Other authors have suggested that optimal muscle protein synthesis occurs when consuming 1.6–2.2 g of protein/kg of body mass, with this amount being consumed 4–5 times throughout the day[8]. In addition, it is argued that bodybuilders should decrease their calorie reduction during the pre-competition period to a level that ensures a weekly loss of 0.5%–1.0% of body mass, where 15%–30% of calories should be derived from fats, and the remainder from carbohydrates[9].

Despite the clear objectives of achieving optimal muscle "separation" and overall "body aesthetics," the pre-competition nutrition strategies encompass a mix of research-based evidence and the experiential knowledge of bodybuilders and their coaches. Because of the wide range in nutrition intake observed between studies, the primary objective of this study was to compare the pre-competition nutrition practices adopted by Lithuanian bodybuilders competing at the elite international level to those competing at the national level. The elite international bodybuilders participated in prestigious international competitions, including the world and European bodybuilding championships organized by the International Fitness and Bodybuilding Federation (IFBB; www.ifbb.com). If we observe that their nutritional practices differ between nationally and internationally competing bodybuilders it suggests that i) nutritional practices may have an impact on success in bodybuilding competitions that ii) would aid bodybuilders and their coaches to formulate evidence-based nutritional practices to enhance performance and achieve optimal body composition.

Materials and methods

Subjects

Sixteen male bodybuilders who participated in international and national competitions from 2015–2020 were enrolled in the study. Those classified as elite international competitors (IL; *n*=8) had achieved notable success by securing rankings between 1st and 4th place at the World Championships and European Championships organized by the IFBB. Those classified as national-level athletes (NL; *n*=8) had attained rankings between 1st and 6th place at the Lithuanian championships and had not participated in international competitions.

In international competitions, from the competitors who advanced to the final group of six athletes in each competition, two were randomly tested for doping. In national competitions, doping control samples were collected from participants in the finals only, and the number of samples was not regulated. It is worth noting that the Lithuanian Anti-Doping Agency conducted testing on approximately 13%–15% of participants in national competitions each year, thus encompassing a representative proportion of the competing athletes. Some of our participants were tested and returned negative results, but we did not ask if they had utilised performance-enhancing drugs.

Data Acquisition

All 16 bodybuilders completed a questionnaire to provide information such as their height, age, sporting experience, competition experience, significant achievements, body mass during the preparation phase leading up to competition (excluding the last week before competition, when dietary changes are significant), and their daily dietary intake (including liquids and supplements that could impact macronutrient levels) during both the first and penultimate week of preparation. The questionnaire was developed based on the "Dietary Assessment of a Natural Bodybuilding Population" questionnaire (bit.ly/3QqOrAW) (see Supplementary file). To determine caloric, carbohydrate, protein, and fat intake of the bodybuilders, an online calculator (https://bit.ly/3ICvU16) was utilized. Subjects meticulously documented their food intake over a 24-hour period, which was indicative of their overall weekly calorie consumption due to their strict adherence to a prescribed diet throughout the entire week. Macronutrients from fluid intake and supplements were included in the analysis based on manufacturer-provided information from their websites. The weekly reduction in body mass was calculated as the reduction in body mass over the number of weeks, expressed as a % of the starting body mass.

Statistical analysis

The collected data were analysed using IBM SPSS Statistics, version 28. The Shapiro–Wilk test was employed to assess the normality of the data. Data are presented as the mean and standard deviation. To assess differences between the IL and NL groups, and differences in the changes occurring during the pre-competition phase, a repeated-measures ANOVA was performed using time as a within factor (first vs. penultimate week) and group as a between factor (IL vs. NL). An interaction indicated that the change during the pre-competition phase differed between the IL and NL groups. Statistical significance was set at $p<0.05$.

Results

Participant characteristics

Table 1 provides an overview of the participant characteristics. There was no significant difference in age, height, body mass, and sports and competition experience between the IL and NL groups during the pre-competition period. In both groups, body mass decreased during the pre-competition period ($p<0.001$; Table 1). However, the weekly reduction in body mass was lower in the IL vs. the NL group, with rates of 0.57±0.12% and 0.81±0.24%, respectively ($p=0.048$).

Changes in macronutrient intake

Table 2 indicates that the athletes in the IL group had a larger caloric ($p=0.015$) and protein ($p=0.003$) intake compared with those in the NL group, whereas there was no

Table 1. Detailed characteristics of the study subjects.

Characteristics	Groups		
	NL (n=8)	IL (n=8)	p
Age (years)	35.3±10.2	32.5±9.7	0.588
Height (m)	1.78±0.06	1.79±0.05	0.904
Sports experience (years)	12.6±8.4	12.5±6.1	0.973
Competition participation experience (years)	5.5±4.1	6.9± 3.6	0.486
Pre-competition period (weeks)	13.0±3.0	14.6±2.2	0.239
Body mass at the start (kg)	98.5±6.6	97.1±11.0	0.766
Body mass at the end (kg)	87.9±5.9*	88.6±9.0*	0.847
*Data are shown as mean±SD. Symbol: * p<0.05 for the comparison with the start of the pre-competition period.*			

Table 2. Amounts of energy and nutrient consumption.

Variables	Units	Time	NL	IL
Calories	(kcal/d)	Start	2374±378	3149±579 †
		End	1745±328 *	2188±589 *
	(kcal/kg/d)	Start	24.2±4.2	32.3±3.2 †
		End	19.8±3.4*	24.6±6.4*
Protein	(g/d)	Start	237±39	307±61 †
		End	201±45*	279±45* †
	(g/kg/d)	Start	2.40±0.33	3.15±0.49 †
		End	2.28±0.46	3.15±0.40 †
	% of diet (%kcal)	Start	40.8±4.8	39.4±6.7
		End	46.4±9.7*	49.6±10.9*
Carbohydrate	(g/d)	Start	190±60	267±65
		End	136±72*	137±71*
	(g/kg/d)	Start	1.97±0.50	2.73±0.46
		End	1.52±0.70*	1.52±0.78*
	% of diet (%kcal)	Start	32.6±10.2	33.2±5.1
		End	31.1±13.6	27.3±10.6
Fat	(g/d)	Start	70.7±42.4	94.8±38.8
		End	44.5±37.6*	59.8±37.1*
	(g/kg/d)	Start	0.73±0.48	0.97±0.38
		End	0.52±0.46*	0.68±0.44*
	% of diet (%kcal)	Start	26.6±12.3	26.7±9.4
		End	22.5±15.9	23.6±11.6
*Data are shown as mean±SD. Symbol: * p<0.05 for the comparison with the start of the pre-competition period; † p<0.05 for the comparison with the NL group.*				

significant between-group difference in carbohydrate and fat intake. Both groups showed a reduced caloric (p<0.001), protein (p=0.019), fat (p<0.001), and carbohydrate (p<0.001) intake during the pre-competition period.

The caloric (p=0.006) and protein (p<0.001) intake per unit of body mass was higher in IL than they were in NL athletes; however, there was no significant difference in carbohydrate and fat intake between IL and NL athletes. Moreover, both groups exhibited a significant reduction in caloric (p<0.001), carbohydrate (p=0.001), and fat (p=0.006) intake, but not in protein intake.

The proportion of energy derived from fat, carbohydrates,

and protein did not differ significantly between the groups, whereas the proportion of protein intake was increased (main effect, $p<0.001$) to a greater extent in IL vs. NL athletes (time × group interaction, $p=0.039$). It is noticeable that both groups show substantial inter-individual variability in macronutrient intake, both at the start and the end of the pre-competition phase, as reflected by the SDs in Table 2.

Discussion

The main finding of this study was that Lithuanian IL and NL bodybuilders applied similar weight-loss strategies and attained similar reductions in body mass during the pre-competition period. However, the higher-level athletes achieved body mass reduction at a slower rate, with a greater calorie consumption. It is also imperative to recognize the substantial individual variability observed in both groups, which is likely attributable to factors such as the initial body mass and preparation duration. The present study provides insights into the dietary competition preparation strategies of competitors.

During the pre-competition period, bodybuilders aim to reduce body fat while preserving muscle mass[10-12]. To maintain lean body mass, it is recommended to achieve a gradual rate of body mass loss ranging from 0.5–1% per week[9,13,14]. In our study, the rate of weekly body mass loss was 0.57% for IL bodybuilders and 0.81% for NL bodybuilders; however, both groups achieved similar absolute body mass loss (about 9.6 kg). Therefore, both groups of athletes were in the recommended range of body mass loss, although this ratio was lower in the IL vs. the NL subjects, which was likely related to both a slightly longer preparation period length (13 vs. 14.6 weeks) and a larger calorie intake. These findings align with those of a previous study[15], which suggests that a slower rate of body mass loss is an effective pre-competition strategy, with Lithuanian IL bodybuilders achieving better outcomes compared with NL bodybuilders. To potentially preserve greater lean body mass, it may be advisable to extend the pre-competition period so that the weekly loss of body mass can be kept closer to the lower end of 0.5–1% per week[12,15]. In fact, some professional bodybuilders have applied pre-competition periods of up to 26-28 weeks[5,15], it is not known whether this practice is associated with a better competition outcome.

Pre-competition macronutrient and energy intake

The common pre-competition strategy among bodybuilders is reducing caloric intake, increasing protein consumption, and maintaining fat as a percentage of total calories[9], while carbohydrate consumption may be adjusted according to the rate of body mass loss. The initial calorie calculations are sometimes based on formulas[16]; however, these formulas serve as a guide and are modified during the pre-competition period based on the rate of body mass and/or fat loss.

In our study, both groups of Lithuanian bodybuilders significantly reduced their caloric intake during the pre-competition period; IL athletes decreased their caloric intake by approximately 30.5%, whereas NL athletes reduced their caloric intake by 26.6%. However, IL bodybuilders consumed approximately 3150 kcal compared with about 2350 kcal for NL athletes at the start of this period. Moreover, at the end of the pre-competition period, the IL group still exhibited a higher calorie intake than did the NL group. A similar pattern was observed in the study reported by Chappell et al.[15], who showed that professional bodybuilders reduced their calorie intake from 3533 to 3018 kcal (15%), whereas amateur bodybuilders reduced theirs from 2968 to 2329 kcal (22%). In addition, another study performed by Chappell et al.[6] revealed that the pre-competition calorie reduction was comparable between different-level athletes, ranging from 17–20%, whereas it remained at >2650 kcal for higher-level and < 2250 kcal for the lower-level bodybuilders, on average. This suggests that higher-level bodybuilders tend to consume more calories compared with lower-level individuals before and during the pre-competition period. Nevertheless, a high variability existed between Lithuanian individuals, with a wide range of 19-37 kcal/kg/day at the start and of 14–34 kcal/kg/day at the end of the pre-competition period.

Protein

Protein intake is of great importance in bodybuilding, as it is widely recognized that exercise and optimal protein consumption enhance protein synthesis in muscles. The recommended protein intake varies according to whether the individual is in positive (aiming to increase muscle mass) or negative (aiming to optimize 'muscle separation' before competition) caloric balance[17]. When in positive caloric balance, consuming more than 1.6 g/kg of protein per day does not lead to greater muscle protein synthesis during strength training[18]. Similar findings were obtained in the meta-analysis reported by Tagawa et al.[19], who concluded that the optimal protein amount for strength gain is 1.5 g/kg/day. Schoenfeld and Aragon[8] suggested that, to maximize protein synthesis during strength training, 1.6–2.2 g of protein/kg of body mass should be consumed across 3–4 servings throughout the day.

However, when in a negative caloric balance, a higher protein intake is recommended[20]. Pre-competition protein intake is important during caloric restriction for several reasons: it helps preserve lean muscle mass[20,21] and provides satiety[22], while the digestion and absorption of proteins require more energy compared with other nutrients[23]. In the case of caloric restriction, protein intakes exceeding 2 g/kg of body mass/day[20] and 3.1 g/kg of fat free mass/day[24] have been recommended to retain lean body mass. This extra protein intake, in the face of reduced total energy and fat intake may facilitate body recomposition[25].

In our study, we observed that Lithuanian IL and NL bodybuilders consumed a daily average of 3.2 and 2.4 g/kg of body mass of protein, respectively, at the beginning of the pre-competition period. Despite a decrease in the

absolute daily amount of protein consumed during the pre-competition period, the proportion of protein in the diet increased, as the overall caloric intake was also decreased, but it remained constant in relation to body mass. Although the protein intake observed within the two groups aligned with recommendations[9] and was in accordance with previous findings[26], it is worth highlighting the notably higher protein intake detected among the IL compared with the NL bodybuilders. Similar to our observations, Chappell et al.[6,15] documented a high protein consumption ranging from 2.9–3.0 g/kg of body mass/day at the commencement of the pre-competition phase, which even increased, rather than becoming stable, to 3.1–3.3 g/kg of body mass/day toward the end of the pre-competition phase among high-level bodybuilders.

Fat

The pre-competition diet of bodybuilders often focuses excessively on protein and overlooks the importance of fat. Insufficient fat intake has been shown to negatively impact anabolic hormone levels in the body[27-29]. Particularly testosterone levels are affected by the ratio of consumed nutrients, with fat playing a crucial role[28] and low-fat diets leading to a reduction in testosterone[30]. For strength sports, it is recommended to consume around 20–30% of total calories from fat, to maintain optimal testosterone levels[31]. Strictly adhering to the upper limit of 20–30% fat intake may not always be ideal, as it may hinder the intake of other essential nutrients[9]. Consuming excessive amounts of fat can decrease carbohydrate intake, subsequently lowering insulin and IGF-1 levels, which are vital for maintaining lean muscle mass[32]. However, we found no such inverse relationship between fat and carbohydrate intake in Lithuanian athletes.

It has been observed that the optimal fat intake in the pre-competition phase typically ranges between 15–30% of the total calorie intake, contingent upon various factors[9]. In our investigation, the average proportion of fat intake was approximately 26–27% at the start of the pre-competition phase and did not differ significantly from this value at the end of this phase, despite a reduction of approximately 30% in the total fat consumption. However, this was proportional to the reduction in total calorie intake observed during the pre-competition period. Although there was no significant difference in fat intake between Lithuanian athletes with differing performance levels (IL and NL), a substantial inter-individual variability in fat intake, ranging from 0.1–1.7 g/kg body mass/day, was observed. This implies that a large range in fat intake does not have a major impact on performance, even though a low-fat diet may result in a reduction in testosterone[30].

Carbohydrate

The recommended pre-competition carbohydrate intake ranges from 2.0–5.0 g/kg of body mass/day (see review[26]). Interestingly, in the pre-competition period, IL bodybuilders were at the lower end of that range and the daily carbohydrate intake in the NL group was even below this range. This may be attributed to the goal of reducing calories by prioritizing the reduction of carbohydrates while maintaining adequate amounts of other nutrients to meet their energy requirements during training; however, the attenuation of muscle hypertrophy may be an adverse consequence[33].

The dietary approach adopted by bodybuilders in the pre-competition phase primarily involves limiting the carbohydrate intake. Adjustments in carbohydrate consumption are made based on body visual appearance and the rate of changes in body mass. It is important to note that there exists a minimum threshold for carbohydrate intake, below which both performance and lean body mass may be compromised[32,33]. Interestingly, some bodybuilders even slightly increase their carbohydrate intake just before competitions, to prevent any decrease in lean body mass[9,32] and perhaps prevent atrophy that may occur in response to a lower carbohydrate intake[33]. This was observed here for the Lithuanian NL bodybuilders, who exhibited an increased proportion of carbohydrates in their diet as the competition approached. Similar trends of pre-competition carbohydrate reduction have been reported by other studies[6,15].

Study limitations

The limitations of this study are consistent with those of similar research[6,15,34]. First, all data were self-reported, which potentially introduced errors that could impact the assessment of dietary intake, although it is habitual for bodybuilders to regularly monitor their diet. Second, the study did not account for the source, dosage, timing, and pattern of nutrient consumption which may be significant for optimal stimulation of protein synthesis[8,17,35]. Moreover, it was not possible to document the changes in fat mass or lean body mass changes during the study, and it remains possible that IL athletes were more muscular given their competitive standing, despite having a comparable body mass, which could have impacted their nutrition strategy. Furthermore, successful bodybuilders might have undergone more rigorous resistance training compared with the less successful bodybuilders. These factors should be considered when interpreting the results of the current study. Finally, drug testing was conducted in approximately 25% of participants, raising the possibility of undetected doping among unchecked individuals. Nevertheless, the high likelihood of detection and the severe, long-lasting consequences for the athletes' careers make it unlikely that doping significantly influenced the collected data.

Conclusion

The groups of Lithuanian IL and NL bodybuilders both employed calorie-reduction strategies in the pre-competition period, which was realized via a reduction in fat and carbohydrate intake. The IL group, which attained superior competition outcomes, sustained a higher intake of

calories and protein, both at the beginning and the end pre-competition period. Taken together, these factors caused a similar body mass loss, but the rate was somewhat slower in the IL vs. the NL athletes. These results provide further information on pre-competition practices of competitive bodybuilders.

Ethics approval

The study was approved by the Lithuanian Sports University Biomedical Research Ethics Committee (No. TRS (M)-606).

Consent to participate

Before participating in the study each participant read and signed a written informed consent form consistent with the principles outlined in the Helsinki Declaration.

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Dietary Assessment of Bodybuilders in the Pre-competition Period

PLEASE ANSWER All QUESTIONS RELATED TO YOUR CONTEST PREPARATION

If you are unsure about any of the questions, then please ask researcher for clarification.

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Competitor Information

Competitor Class: _____ Age: _____

Smoking Status (please circle): Smoker Non-Smoker

Year's bodybuilding training: _____ Year's competing: _____ Competitions this season: _____

Weeks dieting for competitions (including qualifier if applicable): _____

Contest weight (kg): _____ Weight at start of preparation (kg): _____

Height (cm): _____ Bodyfat % and the method used to estimate: _____
_____

Highest bodybuilding achievement (example: IFBB World Championships, bodybuilding, 3rd place, 2020; Lithuanian Championships, Classic bodybuilding, Open category, 1st place, 2019)
_____
_____

Fluid Intake

Typical daily fluid intake (litres) water/drinks/cups of tea per day _____

Do you use artificial sweeteners? Yes / No

Beverage intake during contest preparation, please tick (✓) as appropriate.

Standard Serving: Can of pop 330ml, Cup of tea 150ml, take away coffee 250ml									
Normal serving	Less than once a month	1-3 per month	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4-5 per day	6+ per day
Coffee									
Espresso									
Tea									
Herbal tea									
Energy drink									
Fizzy drinks									
Diet fizzy drinks									
Alcohol									

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Supplementation

Supplement intake during contest preparation, please tick (✓) as appropriate.

Supplement	Please tick (✓)	Quantity per day, mg/g	Brand (Company) (if know)
Whey proteins			
Casein proteins			
Protein-carbohydrate mixture. Weight Gainers. Composition (%) _____prot. _____ carb.			
Omega-3/Cod liver oil			
Others Protein powder			
BCAA			
Individual amino acid			
Carbohydrate supplement			
Creatine (directly or indirectly)			
Protein/Flapjack Bars			
Pre-workout supplements			
Other			

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Dietary Habits

Please detail the type and amount of food to the nearest gram you were consuming at the start (the first weeks of your contest diet) and final weeks (not including last – peak week) of your contest preparation. M1 – first meal, M2 – second meal, etc.

EXAMPLE

Initial Diet First few weeks of your contest diet	**End Diet** Diet at the end of preparation for the competition, 1-2 weeks before the competition Not last week (peak week) diet
Example: M1: 100g of oatmeal (dry), 3 whole boiled eggs, 60 g banana M2: 40 g of Whey protein (Extreme Nutritition), small apple 70g M3: 150 g of steamed cod, boiled potatoes 200 g	Example: M1: 1 whole boiled egg, 3 boiled egg whites, 1 small apple M2: Boiled chicken breast 200 g, 1 medium cucumber M3: 40 g of Whey protein (Extreme Nutrition)

Your Diet

Initial Diet First few weeks of your contest diet	**End Diet** Diet at the end of preparation for the competition, 1-2 weeks before the competition Not last week (peak week) diet